Observations on the Calling Behaviour of the Jervis Bay Tree Frog *Litoria jervisiensis*

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ABSTRACT

In coastal New South Wales most frog species are observed calling and breeding in the warmer months of the year. One exception to this is the Jervis Bay Tree Frog *Litoria jervisiensis,* which displays a preference for calling and breeding in the cooler months of the year. There are some discrepancies in the published literature on this species, in part due to past taxonomic confusion and some present difficulties in identifying members of the *Litoria ewingi* species-group. At one site on the Kurnell Peninsula near the geographic centre of this species range, surveys conducted from 2008-2009 revealed that the core period for calling for *L. jervisiensis* was April to July. Opportunistic observations of territorial behaviour and dynamic sexual dichromatism were also recorded.

Key Words: *Litoria jervisiensis*; breeding; call; agonistic behaviour; sexually dynamic dichromatism

DOI: http://dx.doi.org/10.7882/AZ.2014.017

Introduction

Most frog species in coastal New South Wales display a preference for calling and breeding during the warmer months of the year from September to March (Lemckert and Mahony 2008). One frog species of particular interest is the Jervis Bay Tree Frog *Litoria jervisiensis* (Duméril and Bibron 1841). This is a small to medium-sized hylid frog of the Australian east coast that is found from Nadgee Nature Reserve on the New South Wales (NSW)/ Victorian border northwards to the Queensland border (Anstis 2013). *Litoria jervisiensis* has a preference for permanent still bodies of water with emergent vegetation (Anstis 2013; Griffiths 2006).

There has been confusion in the past regarding *L. jervisiensis*. This species was confused with the then undescribed *Litoria littlejohni* (White, Whitford & Mahony 1994). The formal description of *L. littlejohni* and the taxnonomic delineation of these two species means that there is no longer grounds for confusion. *L. jervisiensis* and *L. littlejohni* share similarities in morphology, however they can be readily distinguished by call, groin colouration and tadpole morphology. *L. littlejohni* is known from scattered populations along the eastern slopes of the Great Dividing Range where it inhabits ponds and flowing rocky streams with deep pools (White et al. 1994; Griffiths 2006). *Litoria jervisiensis,* in contrast, enjoys a more coastal distribution around permanent ponds and swamps, however, some populations occur away from the coast in permanent ponds where they occur in sympatry with *L. littlejohni,* for example, in Dharawal National Park (Payne pers. obs). The historical confusion about the identity of *L. jervisiensis* and continuing present difficulty in mistaking this species with others in the *L. ewingi* species group (Barker, Grigg & Tyler 1995) calls into question the accuracy of some atlas records and previous published notes on the breeding and calling behaviour of *L. jervisiensis,* for example Moore (1961) and Martin and Littlejohn (1966).

A number of observations have been made on *L. jervisiensis*. White *et. al.* (1980) record *L. jervisiensis* calling from April to October. The breeding biology has been recently described by Anstis (2013, 2002), who states the breeding period as being from 'March to about September' (p. 124). On the other hand, Lemckert and Mahony (2008) evaluated calling records from the New South Wales National Parks and Wildlife Service Atlas, Forests NSW and their own records to identify the core calling period for species in eastern New South Wales. Using these methods, they identified August to May as the core calling period for *L. jervisiensis*. However, they qualify this due to the limited number of records that were broadly scattered across the year. Griffiths (2006) reports that this species is active all year round when conditions are favourable. These discrepancies in the calling period of *L. jervisiensis* may be due to taxonomic confusion or regional variation. In this paper I seek to resolve the calling period of this species at a site on the Kurnell Peninsula, close to the geographic centre of this species range. In the course of these surveys, opportunistic observations were made of territorial calling behaviour and dynamic sexual dichromatism.

Methods

The survey area was located on the Kurnell Peninsula, around 20 km south east of the Sydney CBD. The site was a large artificially-created permanent lagoon with a fluctuating water level depending on rainfall (Figure

1). Sand mining operations led to the creation of the lagoon and the removal of the original ground cover with the vegetation currently dominated by wattles such as *Acacia sophorae* with invasive plants such as Bitou Bush *Chrysanthemoides monifera* and Lantana *Lantana camera*. Native and exotic grasses were prevalent around the water's edge such as Mat Rush *Lomandra longifolia*. In the lagoon itself there were scattered stands of Cumbungi *Typha orientalis*. At this site, *Litoria jervisiensis* was sympatric with *Crinia signifera*, *Limnodynastes dumerilli grayi*, *Limnodynastes peroni*, *Litoria aurea* and *Litoria peroni*.

Surveys commenced from 2000 h to 2200 h EST, monthly from January 2008 to December 2009. Attempts were made to carry out the survey on nights when rain had fallen, however, this was not always possible and some surveys were carried out the night after a rain event. Observations of frog behaviour were based on auditory or visual detections. Only adult frogs were included in the counts (individuals judged to be greater than or equal to 30 mm were considered as being adult). The frogs were spotted with the aid of a 12V 20W halogen head torch. The total number of *L. jervisiensis* observed or detected by call was recorded. Data from the Bureau of Meteorology, Cronulla South station was used for rainfall records. Ambient temperature was recorded using a digital thermometer. In addition to observations of calling and active frogs, opportunistic dip-netting for tadpoles and searches for egg masses were also conducted.

Results

Frog Activity and Calling

Frogs were observed all year round with the maximum number of *L. jervisiensis* calling and observed detected during April to July. Males called from cumbungi or from elevated positions usually on *Acacia* around the waters edge, primarily at night, but occasionally during the day. Female frogs were infrequently encountered in the vegetation on the banks of the dune above the water. In December and January there were large numbers of young and recently metamorphosed frogs, which indicated that breeding had occurred during the core period identified in this study. In addition to the calling and active frogs, amplectant pairs (Figure 2) were detected in May and July of 2009, demonstrating that breeding was occurring during the period of high calling activity between April and July. Searches for tadpoles and eggs of *L. jervisiensis* were unsuccessful likely due to the large size of the site and extensive emergent vegetation creating conditions that were not favourable to opportunistic searches.

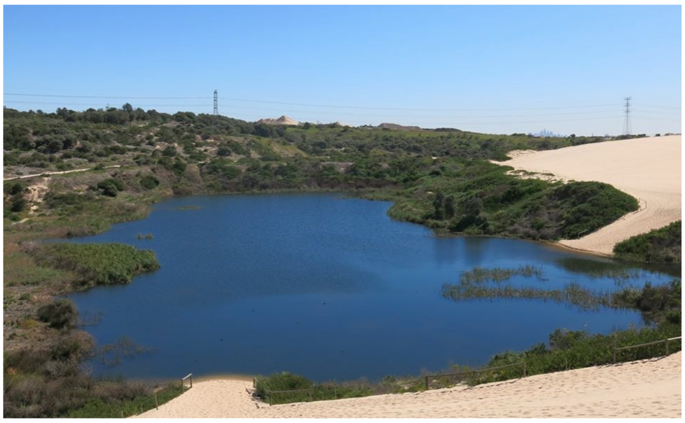

Figure 1. Study site on the Kurnell Peninsula. Large artificial lagoon at the base of sand dune.

In 2008 there was a marked increase in the number of frogs observed and calling during the colder months and this did not always correspond with high levels of rainfall (Figure 3-4). Higher rainfall was recorded in August 2008, but the abundance of frogs seen and calling was not as high as recorded in previous months. The number of frogs recorded increased as the ambient temperature declined below 15°C (Figure 4). With the exception of August, where the heavy rainfall stimulated some low activity, the number of frogs recorded steadily declined as the temperatures rose. In 2008 the highest numbers of frogs detected was from late autumn to mid winter from April to July. In 2009 the abundance of frogs seen and heard calling were similar to those found in the previous year. The number of frogs detected peaked in June at a time of higher rainfall during the survey period (Figure 3). There were rainfall peaks in March and October in 2009, which did not stimulate a comparable rise in the number of frogs recorded.

Territorial Calling, Agonistic Male Behaviour and Sexual Dichromatism

Territorial behaviour was observed amongst male frogs when large aggregations were present. An aberrant call (presumed to be an 'encounter call') was of a higher pitch and faster pace than those produced by other *L. jervisiensis*. Examination of calling frogs revealed that male frogs appeared to be making these encounter calls when another calling male appeared in close proximity. In one instance, two male frogs were calling from an elevated position near the water body when one frog began producing the territorial call referred to previously. This frog then moved towards to the other calling male frog and proceeded to place its hands downwards on the head of its rival and crawl on top (Figure 5). The submissive

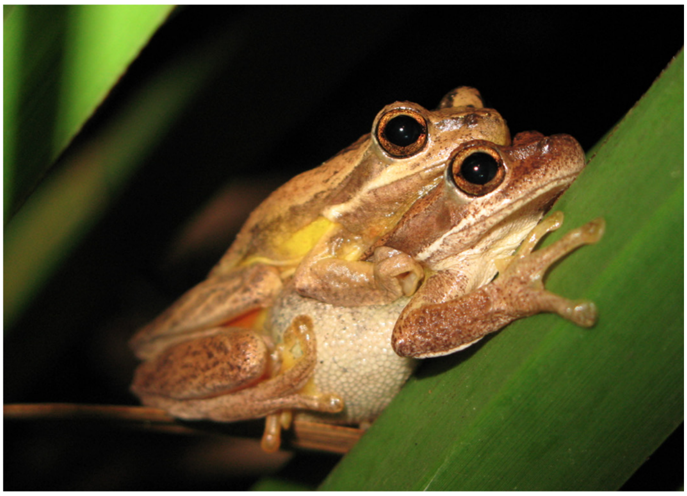

Figure 2. Amplectant *Litoria jervisiensis* at study site showing colour variation between the male (above) and female (below).

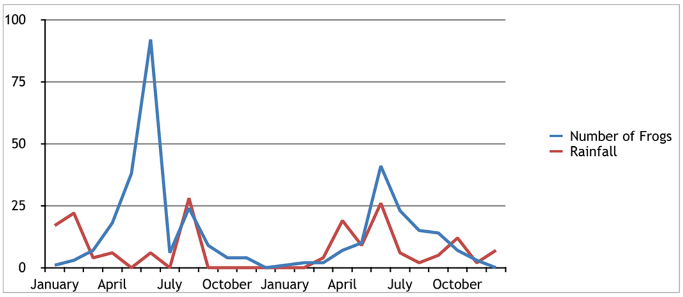

Figure 3. Number of *L. jervisiensis* detected and rainfall (mm) for 2008 - 2009.

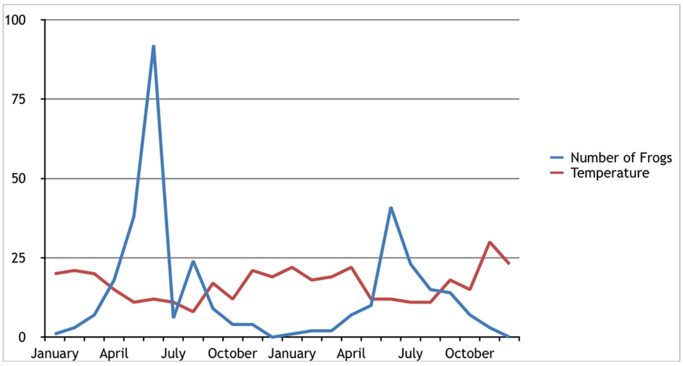

Figure 4. Number of *L. jervisiensis* detected and ambient temperature (oC) for 2008 - 2009.

male ceased calling, then extricated itself from beneath the other frog and moved into the lower foliage. The dominant male then resumed the normal breeding call. Male *L. jervisiensis* were observed to develop a yellow wash over the dorsum in the core period of activity. The dorsum as well as the axilla became a more intense yellow when large numbers of calling males were present. Female frogs remained a reddish-brown colouration (Figure 2).

Discussion

These results suggest that relying on museum and other records is not a reliable measure of determining the core activity and breeding periods of Australian frogs. At Kurnell *L. jervisiensis* has a core period of activity and calling between April and July, which is at odds with the August to May period suggested by Lemckert and Mahony (2008). It is likely that species that are primarily active and call during the cooler months will be under-represented in databases that compile opportunistic sightings collated at other times of the year. Despite some increased rainfall events in late winter and early spring, the number of frogs recorded at these times were not as high as those recorded between April and July. This suggests that while rainfall may be a trigger for breeding and a stimulus for calling in many frogs, it appears that *L. jervisiensis* at Kurnell may be more responsive to a combination of low ambient temperatures and rainfall than just to rainfall alone.

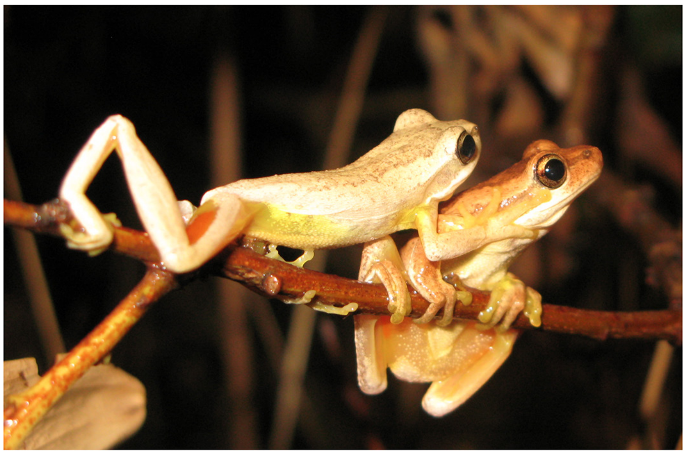

Figure 5: Agonistic behaviour between male *Litoria jervisiensis* at the study site.

Calling and breeding in the cooler months of the year has been documented in a number of Australian frog genera such as *Crinia*, *Neobatrachus*, *Heleioporus* (Main, Lee and Littlejohn 1958) and *Pseudophryne* (Woodruff, 1976). One explanation for this breeding strategy is that parts of south-eastern Australia is dominated by winter rainfall and runoff (Vaze, Teng and Chiew 2011), which facilitates the inundation of ephemeral creeks and swamps. However, this is not likely to be important, at the Kurnell site where the water body is permanent and is not dependent on winter rainfall to maintain water levels. Another more likely explanation for this behaviour in *L. jervisiensis* is that there will be less competition for resources for both the adults and the tadpoles at this time of the year (Tyler 1976). At the Kurnell site the other sympatric hylids, *L. aurea* and *L. peroni* are active and call during the warmer months of the year from late September to March (Payne pers. obs). By having a core period of activity and calling between April and July, *L. jervisiensis* is likely to be better able to exploit resources such as food and calling sites utilised by other frogs at different times of the year.

Aggressive behaviour between males in Australian frogs has been previously documented (Meyer, Murray & Hines 2012; Rowley 2007; Bulbert, Rowley & Miehs 2005), but this is believed to be the first recorded observations of this behaviour in *L. jervisiensis*. Aggression between male frogs typically occurs during the breeding season and one manifestation of this is an encounter call used to maintain inter-male spacing and serves a different function to 'advertisement calls', which are intended for the females (Wells 1977). There is a distinction between aggression to maintain territoriality and individual distance. Territoriality is site fidelity or attachment and intolerance of intruders whereas aggression without site maintenance may be solely to maintain individual distance between males (Shepard 2004). Encounter calls from *L. jervisiensis* were detected irregularly, probably because the site is large allowing for inter-male distances to be maintained. The physical encounter between the two male *L. jervisiensis* occurred once the encounter call failed to serve as a deterrent and is likely to be used as a last resort as it is a disruptive and energetically costly action (Shepard 2004).

Dynamic sexual dichromatism is a temporary colour change that occurs in male frogs during the breeding period (Bell and Zamudio 2012). This phenomenon has been recorded in the stream-breeding hylids *Litoria jungguy*, *L. lesueuri*, *L. wilcoxi* (Donnellan & Mahony 2004; Kriger & Hero 2007) and *L. revelata* (Webster 2013). There are a number of explanations for the purpose of dynamic sexual dichromatism such as sexual selection (Doucet and Mennill 2010); facilitating the distinction between male and female frogs in species that form large breeding aggregations (Sztatecsny et. al. 2012); or the bright colour being evidence of the fitness of the male frog (Bell and Zamudio 2012). *L. jervisiensis* closely resembles *L. revelata* and some authors have placed these frogs in a distinct species-group (Barker et. al. 1995; Wells & Wellington 1985).

In contrast to *L. revelata*, male *L. jervisiensis* do not develop the intense yellow dorsal colouration that is present in the former species and rather the colour change is more muted and only obvious in periods of heightened calling activity and in amplexus. Male *L. jervisiensis* for most of the year are a pale brown or fawn colouration with a darker longitudinal band running down the midline of the dorsal surface. In the breeding period when large aggregations of males occur, the male frogs develop a yellow wash over the dorsum as well as brighter yellow on the flanks and particularly in the axilla. The advantages of these dynamic colour changes are not clearly understood in the case of *L. jervisiensis*. The colour change in the male could be to distinguish them from other males when large aggregations occur to reduce the risk of being amplected by another male frog as well as being a visual signal of the fitness of the calling male.

Acknowledgements

I would like to thank Peter Payne, Georgia Payne and Christine Barnard for assistance in the field. Thank you also to Arthur White and Garry Daly for their helpful feedback on the original manuscript.

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